A biopsychosocial approach to examining child health disparities

Rebecca E. Hasson, PhD, FACSM
Translational research program

- Disparities: Racial/ethnic differences in obesity-related metabolic abnormalities
- Mechanisms: Environmental, behavioral, and biological determinants of metabolic health disparities
- Interventions: Design and implementation of behavioral interventions to reduce disparities
Research training

- University of Massachusetts, Amherst
  - Department of Kinesiology

- University of Southern California
  - Department of Preventive Medicine

- University of California San Francisco
  - Department of Family and Community Medicine
Kids are STRESS OUT!

Academic pressures

Interpersonal conflicts and bullying

Heightened self-consciousness due to weight

Heightened self-consciousness due biological changes

Weight-based teasing, rejection, bullying (2x risk)

"Fitting in"

Familial pressures regarding weight

Critical period of adolescence

COVID-19

STRESS EXPOSURE
self-reported discrimination, community violence

SOCIETY  SCHOOL  INDIVIDUAL  NEIGHBORHOOD  FAMILY

STRESS APPRAISAL
Demands > Resources

BIOLOGICAL STRESS RESPONSES
HPA axis activity

BEHAVIORAL COPING STRATEGIES
stress eating, physical inactivity

TYPE 2 DIABETES RISK
insulin resistance, beta-cell dysfunction
Classic conceptualization of stress

**Stress** is a psychological process—a function of the individual’s appraisals of the situation.

An individual appraises a situation as threatening when his/her/their estimates of the **demands** presented by the situation are greater than the **resources** he/she/they have available to meet those demands.

**DEMANDS > RESOURCES = STRESS**

American Psychological Association, APA Working Group on Stress and Health Disparities, 2017
Classic conceptualization of stress

Stress can be perceived when the demands are:

- **Physical** - fighting off a physical attack
- **Psychological** - facing a loss, humiliation, or failure

Stress can be perceived when the demands are:

- **Unpredictable**
- **Uncontrollable**
- **Dangerous**

**DEMANDS > RESOURCES = STRESS**

American Psychological Association, APA Working Group on Stress and Health Disparities, 2017
Community violence

**Physical threat** to one’s well being through
- Direct victimization
- Direct witnessing

Increased violence exposure within schools:
- Shooting
- Hearing gunshots
  - 62% of adolescents reported hearing gunshots

DEMANDS > RESOURCES = STRESS

Racial discrimination

Being treated unfairly because of one’s race is a psychological demand directly affecting one’s

- Self worth, sense of belonging
- Can also be classified as a physical threat

Being racially discriminated against within different contexts such as:

- School, peers, institutions

72% of adolescents report experiencing racial discrimination

DEMANDS > RESOURCES = STRESS

Cortisol and metabolic health

- Inhibits insulin-dependent glucose uptake in the periphery
- Increases visceral fat accumulation
- Increases release of pro-inflammatory cytokines
- Increases inflammation

CORTISOL

Adipose tissue

Skeletal muscle

Chronic stress and type 2 diabetes risk

**Short term glucocorticoid exposure**
- Increase energy availability
- Inhibits insulin secretion
- Increases hepatic glucose output

**Prolonged glucocorticoid exposure**
- Directly inhibits insulin secretion from pancreatic beta-cells
- Impairs insulin-mediated glucose uptake
- Disrupts the insulin signaling cascade in skeletal muscle
- Increases visceral fat accumulation
- Increases release of pro-inflammatory cytokines

TC Adam and RE Hasson et al., JCEM, 2010; MF Dallman et al., Front Neuroendocrinol, 1993; TC Adam et al., Physiology & Behavior, 2007; MH Antoni et al., Nature Reviews Cancer, 2006
Diurnal cortisol response

Prolonged, high levels of psychological stress appraisals have been associated with dysregulated diurnal cortisol patterns.

Portion of the diurnal cortisol pattern that is the most sensitive to stress.

Directly related to:
- Blood glucose levels
- Insulin sensitivity
- Type 2 diabetes risk

Thorn et al., Psychoneuroendocrinology, 2006; Bruehl et al., Psychoneuroendocrinology, 2009; He et al., PLoS One, 2015
Community Violence and CAR

Covariates in analyses: sex, BMI, pubertal development, race, perceived stress

* J Wexler et al., Psychoneuroendocrinology, 2020
Racial discrimination

Abstract

Objective: The purpose of this study was to examine the relationships between environmental factors, including household education, community violence exposure, racial discrimination, and cultural identity, and BMI in African American adolescents.

Methods: A community-based sample of 198 African American youth (120 girls, 78 boys; ages 11–19 years) from Washtenaw County, Michigan, were included in this analysis. Violence exposure was assessed by using the Survey of Children’s Exposure to Community Violence; racial discrimination by using the Adolescent Discrimination Distress Index; cultural identity by using the Acculturation, Habits, and Interests Multicultural Scale for Adolescents; and household education by using a seven-category variable. Measured height and body weight were used to calculate BMI.

Results: Racial discrimination was positively associated with BMI, whereas household education was inversely associated with BMI in African American adolescents (discrimination: $\beta = 0.11 \pm 0.04$, $p = 0.01$; education: $\beta = -1.13 \pm 0.47$, $p = 0.02$). These relationships were significant when accounting for the confounding effects of stress, activity, diet, and pubertal development. Significant gender interactions were observed with racial discrimination and low household education associated with BMI in girls only (discrimination: $\beta = 0.16 \pm 0.05$, $p = 0.003$; education: $\beta = -1.12 \pm 0.55$, $p = 0.045$). There were no significant relationships between culture, community violence exposure, and BMI (all $p > 0.05$).

Conclusions: Environmental factors, including racial discrimination and low household education, predicted higher BMI in African American adolescents, particularly among girls. Longitudinal studies are needed to better understand the mechanisms by which these environmental factors increase obesity risk in African American youth.

Keywords: adolescents; cultural identity; ethnicity; obesity; stress

Racial Discrimination and Low Household Education Predict Higher Body Mass Index in African American Youth

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Racial discrimination and diurnal cortisol slope

**TABLE 3. Unstandardized β Coefficients and Standardized β Coefficients for Cortisol Patterns**

<table>
<thead>
<tr>
<th>Context of Racial Discrimination</th>
<th>Unstandardized B (SD)</th>
<th>Standardized β</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Baseline Cortisol (Log-Awakening Cortisol)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cumulative racial discrimination</td>
<td>1</td>
<td>−0.014 (0.007)</td>
</tr>
<tr>
<td>Peer racial discrimination</td>
<td>2</td>
<td>−0.031 (0.020)</td>
</tr>
<tr>
<td>Educational discrimination</td>
<td>3</td>
<td>−0.026 (0.020)</td>
</tr>
<tr>
<td>Institutional discrimination</td>
<td>4</td>
<td>−0.024 (0.016)</td>
</tr>
</tbody>
</table>

SD = standard deviation; AUCg = area under the curve with respect to ground.

Models 1–4 include log-based baseline (awakening) cortisol outcome. Models 5–8 include log-based diurnal cortisol AUCg outcome. Models 9–12 include ∆0–30 min cortisol outcome. Models 13–16 include diurnal cortisol slope outcome. All models included sex, body mass index percentile, pubertal development, race, and perceived stress as covariates.

Bold font denotes p < .05.

* p < .05.

**JE Emlaw et al, Psychosomatic Medicine, 2023**
Stress appraisal

- **Challenge stressor** - a demanding but controllable situation where a person has adequate resources to cope the stressor
  - Higher SNS activation

- **Threat stressor** - a demanding situation where one does not have the resources to cope well with, or has the associated components of ‘distress’ (feeling defeated, fearful)
  - Higher HPA-axis activation

Trier Social Stress Test

TC Adam and E Epel, Physiol Behav., 2007; C Kirschbaum et al., 1993.
Cortisol and cardiovascular reactivity

RE Hasson et al., J Interpersonal Violence, 2021
Community violence and stress reactivity

- Exposure to community violence may act to exacerbate autonomic dysregulation in African American adolescents with overweight/obesity.
- Exposure to racial discrimination was not associated with stress reactivity.

RE Hasson et al., J Interpersonal Violence, 2021
STRESS EXPOSURE
self-reported discrimination, community violence

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BEHAVIORAL COPING STRATEGIES
stress eating, physical inactivity
Psychological demands during adolescence

Increased stress

Heightened cortisol response

Eating behavior & Physical activity

Adolescents at a higher weight status

Roemmich et al., ESSR, 2014; Lupien et al., Nature Rev Neurosci., 2009; Goldschmidt et al., Obesity, 2008; Beukes, Walker, and Esterhuys, Stress and Health, 2010; Rancourt and McCullough, Curr Diab Rep., 2015
Cortisol and stress eating

- Mixed findings between stress and food intake in humans
- Our lab has previously found that following a laboratory stressor, overweight/obese youth do not stress eat

*M.R. Nagy et al., Psychosomatic Medicine., 2019*
Psychological stress and disordered eating

- Disordered eating: deviation from normal, socially acceptable, health maintenance-focused approach to food.
  - Extreme caloric restriction
  - Skipping meals
- Our findings: Increased psychological stress was associated with increased dieting behavior among adolescents with overweight/obesity.

<table>
<thead>
<tr>
<th>Dieting behavior</th>
<th>β</th>
<th>SE</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dieting</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Psychological stress</td>
<td>0.15</td>
<td>0.06</td>
<td>0.016*</td>
</tr>
</tbody>
</table>

TA Ajibewa et al., Appetite, 2020; TA Ajibewa et al., Child Obesity, 2021.
Psychological stress and physical activity participation

- Psychological stress predicted lowered moderate-to-vigorous physical activity in adolescent boys

<table>
<thead>
<tr>
<th>Predictors</th>
<th>$\beta^*$</th>
<th>SE</th>
<th>p-value</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceived Stress</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boys</td>
<td>-0.7</td>
<td>0.3</td>
<td>.03*</td>
<td>-1.3, -0.1</td>
</tr>
<tr>
<td>Girls</td>
<td>0.3</td>
<td>0.2</td>
<td>.22</td>
<td>-0.2, 0.7</td>
</tr>
<tr>
<td>Boys vs Girls</td>
<td>0.9</td>
<td>0.4</td>
<td>.01*</td>
<td>0.2, 1.7</td>
</tr>
</tbody>
</table>

KC McGlumphy et al., Am J Health Behav, 2018
Psychological stress and physical activity enjoyment

- Strongest predictor of continued physical activity participation
- Increased psychological stress is associated with lowered exercise enjoyment

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self-reported discrimination, community violence

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PSYCHOLOGY OF HEALTH BEHAVIORS
Racial differences in stress

Compared to non-Latino whites, African American adolescents with overweight/obesity reported greater stress exposure and appraisal and exhibited greater dysregulated cortisol responses.

Hasson et al (unpublished data)
Racial differences in glucose metabolism

Compared to non-Latino whites, overweight/obese African American reported greater AIrG and DI

Hasson et al (unpublished data)
Stress perception and diabetes risk

Paradoxical findings in non-Hispanic whites where type 2 diabetes risk was lower with increased stress.

T.A. Ajibewa et al Physiol Behav. 2021 Dec 11;245:113672.
Positive childhood experiences

https://www.ctdata.org/blog/explore-our-data-portal-on-childhood-experiences
Translational research program

The physiology of racial/ethnic metabolic health disparities

Disparities
Racial/ethnic differences in obesity-related metabolic abnormalities

Mechanisms
Environmental, behavioral, and biological determinants of metabolic health disparities

Interventions
Design and implementation of behavioral interventions to reduce disparities
The stress-buffering effect of acute exercise: Evidence for HPA axis negative feedback

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(d) Department of Psychiatry and Psychotherapy, Charité – Universitätsmedizin Berlin, Charité Campus Mitte, Berlin, Germany

Received 23 May 2014; received in revised form 18 October 2014; accepted 19 October 2014
Stress Buffering with Exercise

- 30 min of aerobic exercise are related to:
  - a blunted cortisol response to a subsequent psychosocial stressor
  - feedback inhibition of the HPA system (via sustained hippocampal activation)
  - exercise-induced increase in positive affect (mood)

Exercise as a Positive Stressor

- Exercise shares several characteristics of an acute stressor
  - requiring hemodynamic, endocrine, and metabolic adaptations to restore homeostasis
  - SNS and HPA-axis systems are activated in an intensity- and duration-dependent manner
  - Can apply the FITT principle to stress/stress responses

- Voluntary aerobic exercise has been labeled a “harmless threat to homeostasis” due to the absence of features characterizing harmful stressors (force, uncontrollability, and threat) and utilization of energy substrates released

*E. Zschucke et al., Psychoneuroendocrinology, 51:414-425, 2015*
Cross-Stressor Adaptation Hypothesis

- The repeated physiological challenge of exercise should result in adaptations which lead to a reduced sensitivity to subsequent exercise and even other types of stressors.

- In trained persons, SNS and HPA responses to absolute (but not relative and maximal) exercise workload are reduced and recovery happens faster, indicating an adaptation to the exercise stressor.

- Single sessions of aerobic exercise have demonstrated improvements in both cardiovascular and emotional reactivity to stress in children.

Sothmann et al, 1996; Hackney et al 2006; Gerber et al 2008
Mental Health Crisis (2022)

- 84% of public schools reported that student behavioral development has been negatively impacted
- 56% increase in student misconduct
- 48% increase in rowdiness
- 48% increase in acts of disrespect to school staff and teachers

Gobel et al, 2016; NCHES, 2023
Teacher training

- Module 1: What and Why of Activity Breaks
- Module 2: InPACT Core Elements
- Module 3: Floor Plans
- Module 4: Classroom Management
- Module 5: Curriculum Integration
- Module 6: Right Videos Right Intensity
- Module 7: Student Motivation & Gamification
- Module 8: Equity & Adaptation
- Module 9: Safety Considerations

InPACT by the numbers

Teachers preferred fewer breaks that lasted 4 minutes.
Students reported an 8 out of 10 on their confidence to complete 30 minutes of physical activity every day at school.

On average, teachers were able to implement 5 activity breaks per day in their classrooms.

Average transition time to activity breaks was 1 minute. The shortest time was 2 seconds.

Children reported a 4.2 out of 5 on an enjoyment scale during activity breaks.

85% of students were exercising at a moderate-to-vigorous intensity.

Teacher feedback

• When asked: “What, if any, changes have you observed since implementing InPACT?”
• 82% reported fewer behavioral issues, and improved student self-regulation
• 86% reported positive mood changes citing student enjoyment, happiness and excitement related to activity breaks
• 95% reported improved students’ focus, engagement, and the breaks being a productive outlet for energy
Implementation Science
How do we reduce low-fidelity implementation?

Health Equity
How do we overcome the barriers that lead to inequitable implementation?

Multi-level supports are needed to overcome to implementation barriers

Regional School Health Coordinators

- Network of regional school health coordinators that provide support, training, technical assistance for health programs and practices in schools

- Key facilitators of InPACT implementation

Eisman et al. Pilot and Feasibility Studies, 2022; 8:204; mischca.org
Improving the health and well-being of Michigan children and their families
InPACT at Home Family Toolkit

• 12 Modules

• Challenge Calendars ➡

• Each module addresses how physical activity supports and intersects with another health-enhancing behavior.

Family Toolkit Aligned to Maslow

- Self-actualization
  (Personal Best, Resilience)
- Esteem
  (Health Choices, Substance Use, Focus, Feeling Good)
- Love and belonging
  (Family Teambuilding, Lifelong Skills)
- Safety needs
  (Schedules and Routines)
- Physiological needs
  (Nutrition, Sleep)

Foundational Module: Family Discussions
Curriculum Integration

Bringing InPACT at School and InPACT at Home together through integration with a widely used, evidence-based prevention curriculum: The Michigan Model for Health™.

InPACT at School website: https://www.inpact.kines.umich.edu/ Teacher Tab
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Visit us at cdrl.kines.umich.edu

“Improving the health and well-being of children and their families”